City of Busselton
COASTAL MANAGEMENT PROGRAM (2018-2022):

GIS COASTAL LAYER
Metadata and User Information

Shore Coastal
December 2018

1707_02 Coastal GIS Layer -Rev A

1707_02 Coastal GIS Layer Report
Rev A
Draft is dated 13.12.2018

Executive Summary

The scenic coast of Geographe Bay is a sandy coastline that is naturally dynamic. The City of Busselton has managed this coastline for many years, leading it to commission the first integrated coastal management plan by a local government in Western Australia, the Coastal Management Program (2014-2018), prepared by Shore Coastal. The City had systematically collected a lot of coastal data by the time they commissioned Shore Coastal to prepare a second Coastal Management Program (2018-2028). During preparation of this program, coastal information has been identified that could be usefully added to the City of Busselton GIS system. The City engaged Shore Coastal to compile and adapt this information for integrating into the GIS system.

This report and associated data brings this coastal information together for use in the City's GIS system. This information includes

1) Coastal Management Areas.
   The six coastal management areas in Geographe Bay used in the City's Coastal Management Program (2018-2028).

2) Historic coastline movement data.
   Historic vegetation lines are mapped from coastal photography and show how the coastline has moved over time. This data is available from 1941 to 2017 and tracks long term coastal changes.

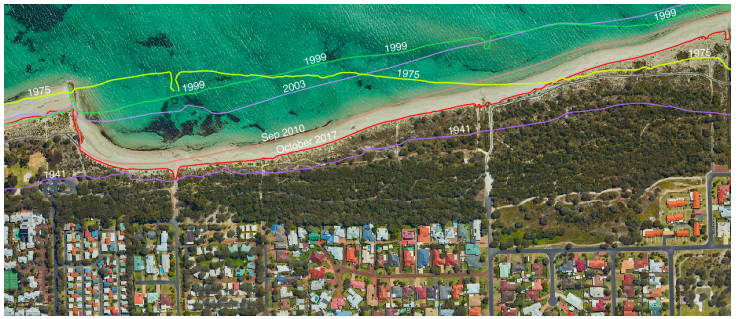

Figure 1: Selected vegetation lines at Broadwater Beach

3) Historic aerial photography.
   Aerial photography provides a visual record of the shape of the coastline at a known time in history. These are collated by Landgate and available for the Geographe Bay Coastline from 1959 to 2018.

4) Extent and nature of coastal surveys.
   Numerous surveys of sections of the coast have been taken over the years. The extent and nature of each survey has been added to the GIS to facilitate ready

access when needed and allow coastal managers to be aware of the extent and availability of coastal surveys.

5) Regular beach photos have been taken every 6 months since December 2013 for 32 monitoring sites under the Coastal Management Programs. Controlled comparison photographs provide objective evidence of movements in the coastline and a visual history of coastal changes.

6) Photo sphere for the 32 coastal monitoring sites. These are "streetview" type images of the coast that provide a 360 degree perspective at key beaches.

Figure 2: Photo Sphere at Locke Estate

7) Locations of coastal protection structures and data on these structures including data on the construction and maintenance of structures.

Figure 3: Coastal Protection Structures (Beachlands- including buried structures)

8) Impacts of the June 2018 storms, the most significant storm event in over a decade. Unmanned Aerial Vehicle (UAV) coastal videos were taken of many sections of coast following the storms.

Figure 4: Cropped screenshot from UAV footage (Broadwater)

Additionally, survey has been taken documenting the extent of ocean flooding inland.

This report outlines the information added to the GIS system, as well as a proposed structure for organising this information.

This report also includes recommendations on utilising this information, which can be very helpful for planning and for any project in the City adjacent to the Geographe Bay coastline. The information added to the GIS under this project will allow any staff member to visualise the dynamic nature of the Geographe Bay Coastline, as well as accessing site specific information for a given project.

Recommendations are also made about the potential for further additions to the GIS and wider use of the coastal information on the GIS.

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Limitations of this Report

This report and the work undertaken for its preparation, is presented for the use of the client. The report may not contain sufficient or appropriate information to meet the purpose of other potential users. Shore Coastal does not accept any responsibility for the use of the information in the report by other parties.

Document Control

Index	Author	Date	Review	Date	Comment
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1. Introduction

During the preparation of the Coastal Management Program (2018-2028) for the City of Busselton, a lot of useful coastal data was identified. It was noted that significant categories of this data could be beneficially integrated into the City of Busselton's Geographic Information System (GIS). Useful information identified for adding to the GIS included:

- Boundaries of the Coastal Management Areas used in the Coastal Management Program
- Historic coastline movement data
- Historic aerial photography
- Extent and nature of coastal surveys
- Regular beach photos every 6 months since December 2014 for coastal monitoring sites
- Panoramic beach photos for coastal protection structures
- Locations and information on coastal protection structures
- Impacts of the June 2018 storms, documented through UAV coastal videos and survey of flood extents.

The City of Busselton commissioned Shore Coastal to collate and prepare the relevant data for integration into the GIS.

Our recommended organisation of this data in the GIS is shown in Figure 1.1

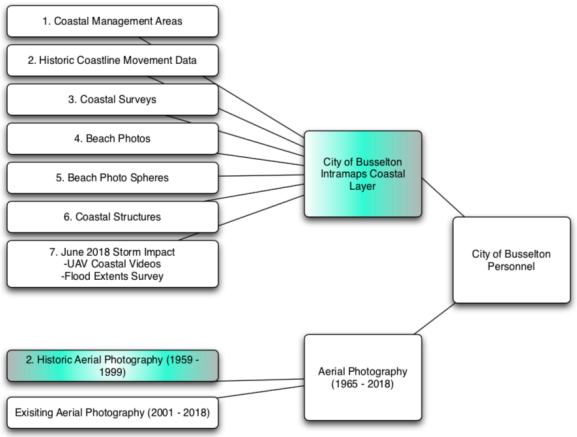

Figure 1.1 Recommended Organisation of Information in GIS

This report outlines the data provided as well as providing recommendations on utilising this information.

2. Information Added to the GIS

2.1. COASTAL MANAGEMENT AREAS

The Coastal Management Program (2018-2028) identifies six coastal management areas to highlight the need for works within one section of coast to consider the influence to/from adjacent areas. The boundaries for these areas are included in the GIS. These areas are summarised in the following table.

Table 1: Coastal Management Areas

Coastal Management Area	Western Boundary	Length of Coast (km)	Coastal Orientation	Description
1. Dunsborough	Old Dunsborough	5.4	NE	Rocky coast of Old Dunsborough, the Dunn Bay bar and the Dunsborough foreshore beaches inshore of the bar.
2. Quindalup-Siesta Park	Dunn Bay Bar	8.5	NNE	Undulating sandy coastline that includes boating facilities, a number of coastal inlets and private coastal residences.
3. Locke Estate-Abbey	Siesta Park Groyne	5.2	N	Sandy coastline with >12 coastal structures including Locke Estate campsites, Buayanup Drain and the Abbey foreshore and boat ramp and commercial tourism developments.
4. Broadwater-West Busselton	Holdgate Rd Groyne	6.2	N	Sandy coastline including eroding Broadwater Beach, West Busselton foreshore including the regional hospital, managed erosion sites (Mill Rd, King St), narrow setbacks and the Busselton foreshore west of the Busselton Jetty.
5. East Busselton	Busselton Jetty	4.3	NNW	Sandy coastline including foreshore east of Busselton Jetty, Scout Rd, Georgette St boat ramp, East Busselton foreshore and wrack accumulations on western beach of Port Geographe.
6. Wonnerup	Port Geographe (to Wonnerup Inlet)	4.4	NW	Sandy coastline including Wonnerup Beach, East Wonnerup (Baudin Reserve) and Wonnerup Inlet.

Figure 2.1.1 Geographe Bay Coastal Management Areas

2.2. HISTORIC COASTLINE MOVEMENT DATA

Historic vegetation lines have been plotted from aerial photos by the Department of Transport, Shore Coastal and Whelans Surveyors. These vegetation lines provide a concise and effective way of communicate the extent of the historic movement of the coastline.

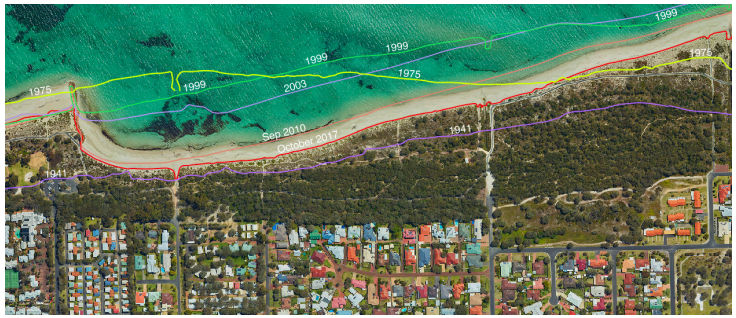

Figure 2.2 Select vegetation lines at Broadwater Beach

While there are agreed methodologies for interpreting these vegetation lines[1], there will inevitably be some variability interpretation as the vegetation lines are mapped. Despite this, the vegetation lines provide an excellent way to track long term coastal changes.

Figure 2.3 Typical Vegetation Line

[1] Department of Transport (2009) *Coastal Demarcation Lined for Administrative an Engineering Purposes: Delineation, Methodology and Specification*

The following vegetation lines were already on the City's GIS system:
1941, 1975, 1985, 1993, 1999, 2001, 2003, 2004, Feb 2008, Dec 2008

The following data has been provided to the City electronically ready for integration into the GIS:

Table 2: Historic Coastline Movement Data Provided

Nature of Data	Dates	Format of Data	Metadata categories
Historic Vegetation Lines	Sep 2010, Mar 2012, Nov 2012, Mar 2013, Nov 2013, Dec 2014, Jan 2016, Oct 2016, Oct 2017	Shape File (.shp) with associated files	ID, year

2.3. HISTORIC AERIAL PHOTOGRAPHY

Historic aerial photography is a source of rich visual information about the coastline at known dates in the past.

Figure 2.4 1975 Aerial from Busselton Jetty Vicinity

The City's GIS system already included aerial photographs from 2001 onwards.

The custodian for most aerial photography in Western Australian is Landgate. Discussions have been held with Landgate with a view to obtaining licences to use aerial photography from two sources:

1) Aerial photography in Shore Coastal's database from work with other clients. (Aerial photography from 1959, 1965, 1975 and 1999.) Shore Coastal has received confirmation from Landgate that this aerial photography may be used by the City of Busselton under its existing "Historical imagery display" licence.
2) Aerial photography visible on Landgate's online MapViewer Plus portal but not yet accessed through the City's existing licence agreement. (Aerial photography from 1996 and partial areas from 1981 and 1959.) Landgate have advised this may be able to be accessed through an extension of the City's existing licence agreement. City's GIS staff are investigating this possibility.

As outlined in the following table, aerial photography files have been provided for integration into the City's GIS system.

Table 3: Additional Aerial Photography

Nature of Data	Dates	Format of Data	Metadata categories
Aerial Photography (geo-referenced)	1959, 1965, 1975, 1999	GTif	ID, year
Aerial Photography (geo-referenced)	1996, partials from 1981 and 1959	Online access through Landgate	

2.4. BEACH SURVEY

Numerous surveys have been undertaken of sections of the coastline at various times. The methodology, accuracy and datums of these surveys varies quite widely, but with interpretation they provide valuable information about the coast.

These surveys were reviewed, and those able to be utilised with a small or moderate level of interpretation were compiled and their extents mapped onto a shape file for integration into the City's GIS. The survey data for these surveys was compiled into files able to be linked to the GIS.

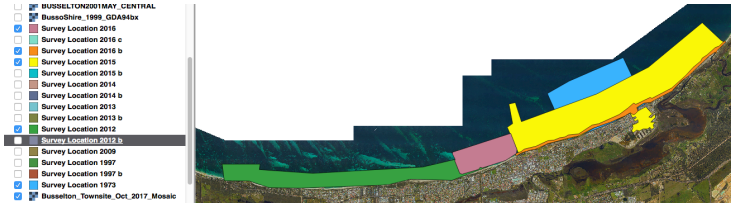

Figure 2.5 Extents of selected surveys

The Department of Transport also collates survey information, which is available through data.wa.gov.au at https://catalogue.data.wa.gov.au/dataset?organization=department-of-transport&q=survey.

Table 4: Beach Survey Data.

Nature of Data	Dates	Format of Data	Metadata categories
Extents of surveys	1973, 1997 (x2), 2009, 2012 (x2), 2013 (x2), 2014 (x2), 2015 (x2), 2016 (x3)	Shape File (.shp) with associated files	Survey Loc, Date, Author, Type
Survey data	1973, 1997 (x2), 2009, 2012 (x2), 2013 (x2), 2014 (x2), 2015 (x2), 2016 (x3)	Generally shape files (.shp). Sometimes .pts files alone or with .xyz files	

2.5. PHOTO MONITORING: HISTORIC COMPARISON (2013-18)

Photographic records provide rich information on the state of the coastline at specific points in time.

In accordance with the *Coastal Management Program (2018-2018)* and the CMP 2018-2028, photographs are taken at specified angles every six months from 32 specified locations along the Geographe Bay Coast in the City of Busselton.

At each of these locations, a comparison sheet of the photos collated by Shore Coastal from December 2013 to June 2018 from one angle has been produced as a pdf file ready for integration into the GIS.

Figure 2.6: Selected Six Monthly Photos from Baudin Reserve (Dec 2013-May 2015)

The summary of the comparative photographic data is included in the table of coastal photographic data in Table 5: Coastal Photography files**Table 5: Coastal Photography files** in the following section of this report.

2.6. PHOTO MONITORING: PHOTO SPHERES

At each photo monitoring location a photo sphere has been taken by Shore Coastal in December 2017. These are "streetview" type images of the coast that provide a 360 degree perspective at key beaches.

Figure 2.7 Photo Sphere at Busselton Jetty Precinct

Table 2.4 outlines the files provided for the GIS for coastal photography, including both six monthly comparisons and photo spheres.

Table 5: Coastal Photography files

Nature of Data	Dates	Format of Data	Metadata categories
Locations of Photo Monitoring Sites		Shape File (.shp) with associated files	ID, site
Photo Comparisons	Dec 2013-June 2018	.pdf	N/A
Photo Spheres	Dec 2017	.jpg	N/A

2.7. COASTAL STRUCTURES INFORMATION

There are over 50 coastal protection structures along the City's Geographe Bay foreshore. As the coastline continues to move, some of these structures are now buried, while others are important for protection of critical infrastructure.

It is useful for all staff involved in foreshore development and planning decisions and planning decisions to have access to information on these coastal structures.

Figure 2.8 Coastal Structures at Beachlands (buried and visible)

Information from the City's Asset Management section was reviewed and supplemented with information Shore Coastal had collated for the CMP and for other projects for the City. This information was prepared for incorporation into the GIS, showing the location of each structure together with information on its construction, location and dates of significant maintenance work.

Table 6: Coastal Structures Data

Nature of Data	Dates	Format of Data	Metadata categories
Locations and Data on Coastal Structures	2018	Shape File (.shp) with associated files	Type, name, material, construction date, management, refurbished/repaired, scheduled maintenance (CMP 2018-28)

2.8. STORM IMPACT FROM JUNE 2018

The winter storm of 05 June 2018 was the biggest storm in over a decade, with strong northerly winds and a peak ocean water level of 2.1mCD (~0.7m above highest astronomic tide). This was the second substantial storm of the winter and followed an event 10 days earlier on 25 May 2018. This storm caused significant erosion and damage to coastal infrastructure.

During the storm, waves and surging water carried seagrass wrack inland. The wrack line left after the water receeded was surveyed to provide a record of the extent of flooding. This June 2018 wrack line has been provided for incorporation into the GIS.

Unmanned aerial vehicle (UAV) video was taken of 9 sections of the City's Geographe Bay coastline in mid June 2018. This video imagery records the impact of the storms, including damage to coastal infrastructure and wrack and sand which surged inland. This imagery also provides a useful overview of large sections of the coastline.

Figure 2.9 Screenshot of UAV drone footage (Locke Estate)

The lines of these UAV flights were plotted for integration into the GIS, with video files provided for linking to the flight lines.

Table 7: June 2018 Impact Data

Nature of Data	Dates	Format of Data	Metadata categories
Coastal Flooding (wrack) lines	June 2018	Shape File (.shp) with associated files	High Water Mark
UAV Flight Paths	June 2018	Shape File (.shp) with associated files	Title
UAV Coastal Videos	June 2018	MP4 Video files	

3. Utilising Coastal GIS information

Once the coastal information is added to the City's GIS system, it will be accessible to all City staff on the internal network simply by selecting the appropriate layer.

3.1. ACCESSING THE GIS INFORMATION

The coastline movement lines, aerial photography and coastal management areas will be visible within the GIS.

Get screen shots

The beach survey and UAV information and will show the areas surveyed within the GIS. When a survey area is interrogated within the GIS, it will provide a link to the survey data or video footage.

Get screen shots

The Coastal Monitoring locations will be single points on the GIS system. These points will be able to be interrogated to show the pdfs of six monthly comparison photos and the jpgs of the panoramic views.

Get screen shots

Each Coastal Structure will be a single point on the GIS system. The points will be able to be interrogated to give information on the construction and maintenance of the groyne, seawall or other structure.

Get screen shots

3.2. BENEFITS OF COASTAL GIS LAYER FOR CITY STAFF

Busselton and Dunsborough have historically developed along the Geographe Bay foreshore. This dynamic coastline is a significant attraction for both locals and visitors, meaning many significant assets are located close to the foreshore.

Coastal movements and high water levels in extreme storms have the potential to impact infrastructure across the City of Busselton. It is therefore important for all staff involved in planning, development, reserves or maintenance to have a basic understanding of the dynamics of the coastline.

The information added to the GIS under this project will allow any staff member to visualise the dynamic nature of the Geographe Bay Coastline, as well as accessing site specific information for a given project. This should facilitate better decision making. It should also reduce the likelihood significant staff time being invested in projects that are not viable because of coastal risk.

3.3. PROVIDING COASTAL GIS INFORMATION TO THE PUBLIC

In addition to the provision of Coastal GIS information to City staff, it would be beneficial to provide some of this information to the public through the City's "Intranet" portal. This could facilitate greater public understanding of the dynamic nature of the coastline. Providing select coastal movement lines and older aerial photography in particular would graphically illustrate coastal movements.

It is recognised, however, that providing a high volume of data that may be misinterpreted has disadvantages as well as advantages. Information recommended to be provided to the public is therefore limited to that outlined in the table below:

Table 8: Information with Potential for Public Access

Information Type	Recommended Public Information	Discussion
Coastline Movements (Vegetation Lines)	1941, 1975, 1993, 2010, 2014, 2017	Provide sufficient vegetation lines to graphically illustrate the dynamic nature of the coast.
Aerial Photography	Add 2010, 2003 and earlier, dependant on licence conditions	Provide sufficient photo layers to graphically illustrate the dynamic nature of the coast.
Beach Survey	-	Technical information for internal use
Beach Photography (Historic Comparison and Photo Spheres)	Possibly include all photo comparisons and photo spheres	Would increase public understanding of coastline dynamics, although not as greatly as movement lines and aerial photography.
Coastal Structures	Include locations and construction, but not maintenance data	Increase public understanding of coastal structures without encouraging public to assume "asset manager" role
Impact of June 2018 storm.	Provide wrack lines. Video dependant on system limitations	Informative and interesting for the public, but video may place a significant load on the IT system
Coastal Management Areas	-	Information primarily for internal asset management

4. Recommendations

1) Add the data provided into the City of Busselton's GIS system

2) Consider the future inclusion of other coastal information into the GIS system, including:
    a. Additional information on boat ramps and finger jetties. Currently the GIS only has name and location for boat ramps. It could be useful to include additional information such as the number of ramps and finger jetties and an indication of the boat trailer parking available at the site.
    b. Storm surge information from the *Coastal Flooding Risk, Response and Mitigation* (2017) and *Busselton Storm Surge Response* Plan (2015) reports prepared for the City of Busselton by Shore Coastal. While care needs to be taken in distributing modelling of extreme and low probability storm surge events, appropriate information could be selected for inclusion in the GIS. As a variation on this, colour coded topographical maps could be produced to highlight low-lying areas.

3) Ensure relevant Council staff, including officers in engineering, planning and works, are aware of the Coastal layer in the GIS system and its uses. Means for doing this include a launch event and as an agenda item in meetings as well as electronic communications.

4) Make select sections of the Coastal layer information available to the public.

Appendix 1: Data Transfer Sheet